this to have been fully 100 times too wide. 5^{mm} in the focus of the 8-inch object-glass would correspond to 6′ of arc. It seems hard to see what purpose a slit of so great a width would serve, and in what essential feature it differed from no slit at all. And it is also difficult to place much confidence in measures made with so wide a slit, especially as the collimator only measured 6 inches in focal length, so that no stress can be laid upon the correspondence between the bright lines observed, and those seen in the solar chromosphere.

The most suspicious circumstance of all, however, is, I think, that so far Mr. Sherman has never failed to see bright lines in any star which he has examined; and that though "sometimes they shine with almost a metallic brilliancy," yet no previous observer has ever detected them.

My experience of bright lines in stellar spectra has been limited to γ *Cassiopeiæ*, and perhaps *Nova Andromedæ*. But I have had occasion to notice on more than one occasion that a stellar spectrum which is full of dark lines or bands may, when badly seen, give a very perfect illusion of bright lines; the dark lines escaping recognition as such, but producing their effect by making the parts of the spectrum most free from them shine out by contrast like a veritable chromospheric spectrum. I have also, in my measures of the displacement of lines in stellar spectra, used on some 100 stars a dispersion considerably greater than Mr. Sherman's, the very greatest, in fact, the star would bear, without bringing up the faintest trace of a bright line; so that I cannot put down my own failure to detect these lines to insufficient dispersive power.

Since I commenced to draw up this note, Prof. Vogel has criticised* Mr. Sherman's observations in the *Astronomische Nachrichten*, on grounds which closely correspond to some of those which I have here brought forward; but he mentions in addition the mistake which Secchi fell into with regard to the spectrum of *Sirius*: an instance which shows how readily even an experienced spectroscopist may be made the victim of an instrumental illusion.

II. Observations of the Spectrum of *Nova Orionis*. Dr. Ralph Copeland. *Monthly Notices*, vol. xlvi. No. 3.

In venturing to criticise Dr. Copeland's paper on the spectrum of the new star near χ_1 *Orionis* read before this Society at the January meeting, I have not the smallest intention of calling in question the observations themselves. These are undoubtedly very accurate; the only point open to question is the interpretation to be put upon them. There is no doubt as to the general appearance of the spectrum. It resembles the spectra of Secchi's third type, of which α *Orionis*, α *Herculis*, *Mira Ceti*, and β *Pegasi* are amongst the best known examples. But the contrasts of

* *Astron. Nachr.* No. 2712.

light and darkness are unusually pronounced, so that it becomes a question whether we ought to regard the spectrum as consisting of a brilliant continuous spectrum crossed by intensely dark bands, or of a feeble continuous spectrum, with vivid bright bands superposed upon it. It is, in fact, a somewhat similar question to that raised by Dr. Henry Draper with regard to the existence in the solar spectrum of bright lines due to oxygen. Hitherto all observers seem to have preferred the former view; Dunér,* Riccò,* Thollon,† Trépied,‡ Vogel,§ and Wolf,‖ however much inclined on a first view to believe in the presence of bright lines, all agreeing on more careful scrutiny to see in the spectrum of the new star but an unusually fine example of the third type, showing no very essential points of difference from that, for example, of *α Orionis*. Dr. Copeland, on the other hand, considers that "the spectrum is not so much a continuous one, interrupted by dark lines and dusky bands, as *a not very luminous spectrum upon which a series of bright bands are superposed.*" Further, he identifies some of these bands, as those so well known to us as characteristic of hydro-carbon and of cometary spectra.

Of the importance of this view, if it can be substantiated, there can be no doubt. We cannot confine it to a single member of the type, but must regard *all* the stars of Secchi's third group as possessing a similar constitution. For the characters and positions of the bands are practically the same throughout all the members of the group; the only difference being in their comparative intensity. And in this respect we have every conceivable gradation from the bold and beautiful contrasts of the present star and of *α Herculis*, *ρ Persei*, *Mira Ceti*, and others, down to stars in which they can only just be detected. Further, many of the stars being variable, the intensity of the contrasts often varies from time to time in the same spectrum; so that there is no possibility of drawing a line, and saying, "These stars have bright bands on a feeble background, and the others dark bands on a bright background." The verdict passed on *Nova Orionis* must be passed on all the members of the same type.

The hypothesis is certainly a tempting one. Seeing that we possess spectra intermediate in character between a true solar and a pure banded type, we might, on the one hand, well be tempted to push Dr. Draper's views a little further, and see not only bright oxygen lines in some of the clear interspaces of the solar spectrum, but to find in others traces of hydro-carbon bands; while, on the other hand, the red stars plainly show an absorption spectrum corresponding to the hydro-carbon bands; so that the spectroscopic chain connecting together comets and the various orders of stars would be complete.

* *Astron. Nachr.* No. 2707.
† *Comptes Rendus*, vol. cii. No. 7
‡ *Ibid.* vol. cii. No. 1.
§ *Astron. Nachr.* No. 2704.
‖ *Comptes Rendus*, vol. ci. No. 26.

But there are several difficulties in this view. First, the dark bands of spectra of the third type must be regarded as true absorption bands, and not merely as traces of a very feeble continuous spectrum appearing dark only by contrast with the vivid bright bands superposed upon it, for under favourable circumstances they have been resolved into separate fine lines; and M. Wolf believes that he has been able so to break up the bands in the spectrum of *Nova Orionis* itself. And, secondly, though at present we are unable to draw any particular inference from the fact, it can hardly be a chance coincidence that in each case the more refrangible edge, the sharp dark edge of these bands, agrees in position with some well-marked metallic line, usually with one ascribed either to iron or calcium.

Then, further, the districts of the spectrum which Dr. Copeland considers to be bright bands correspond in every case to districts which, in other spectra of the type, are simply free from absorption bands or lines. Line by line, band by band, every object Dr. Copeland has considered as a bright line or band corresponds with what in other spectra are simply regarded as clear spaces; the only difference is the somewhat greater comparative brilliancy of these spaces in *Nova Orionis*. Undoubtedly if the continuous spectrum be very bright, and the absorption bands very dark, these spaces very greatly resemble bright lines in appearance. They do so in α *Herculis*, ρ *Persei*, and several others when viewed with small dispersion, but the illusion promptly disappears when a great dispersion is employed. And in the particular instance before us, M. C. Wolf records that, though the *Nova* seemed at first to present bright lines in the blue and green, with greater dispersion he could not establish the presence of a single line.*

Further, the coincidence of Dr. Copeland's bright lines and bands with those of the hydro-carbon spectrum is by no means exact. The positions of these bands are now known with great exactness, the different investigators who have determined them agreeing very closely indeed in their results. In all, five of these bands have been detected in the spectra of comets; two of them, the red and violet, having been only rarely seen. But the other three have been frequently seen, and their exact coincidence with the bands of the hydro-carbon spectrum placed beyond dispute. The brightest band is the one in the green, wave-length, according to Thalén,† 5164 tenth-metres. Dr. Copeland identifies this with the bright space immediately following the sharp dark edge of what I have called the dark band VI.‡ But numerous and repeated observations have shown that the edge of this band coincides with the magnesium line b_4, the wave-length of which is 5167. The difference is indeed too small to be detected easily with such dispersion as *Nova Orionis* would bear,

* *Comptes Rendus*, vol. ci. No. 26.
† Angström and Thalén, *Recherches sur les Spectres de la Métalloides*.
‡ *Monthly Notices*, vol. xlvi. p. 114.

but the positions both of the carbon band and of the magnesium line have been determined with far too great a degree of accuracy for the difference to be due to errors of observation. Dr. Copeland is confirmed in his view that this bright space is the green hydro-carbon band by finding a second line at λ 5137. A reference to Huggins and Miller's * drawings of the spectra of *α Orionis* and of Aldebaran at once explains the origin of the second line. The bright space is interrupted here by a strong dark line, ascribed by Dr. Huggins to bismuth. Dr. Copeland's measures, too, scarcely support his view. The wave-length of the hydro-carbon line is 5128; the values Dr. Copeland obtains for his bright line are 5157, 5131, and 5124.

The second band in order of brightness in the hydro-carbon spectrum begins at λ 5634. This is certainly non-existent in spectra of the third type, a broad dark band,—No. 4 in Dunér's nomenclature and my own, wave-length 5642 to 5592,†—occupies the very place. The third hydro-carbon band, that in the blue, with wave-length for its less refrangible edge 4737, is indeed not far from the bright space Dr. Copeland has observed at λ 4722, but the correspondence is certainly not very exact. But whilst the bright spaces in the spectrum of the star answer so very imperfectly to the hydro-carbon bands, the hydro-carbon bands correspond still worse to the bright spaces. As Dr. Copeland himself points out, the spaces at λ 5428 and λ 4944 correspond to no known hydro-carbon band; and there are, besides, bright lines or bands at λ 6110, λ 5841, λ 5771, λ 5592, λ 4923, and λ 4778 to find an explanation for, if the natural one, hitherto accepted, that they are simply the clear intervals between dark absorption bands, be set aside.

III. Les changements temporaires de réfrangibilité des raies du spectre de la chromosphère et des protubérances solaires. M. E. L. Trouvelot.—*Bulletin Astronomique*, January 1886.

The third series of observations of which I wish to speak are contained in a paper by M. Trouvelot in the January number of the *Bulletin Astronomique* on temporary changes of refrangibility of the lines of the spectrum of the solar chromosphere and prominences. Eight remarkable observations are very fully described, and illustrated in a series of 22 diagrams. The observation to which I would more particularly allude is the fifth, which is to the following effect:—M. Trouvelot was examining the limb of the Sun on June 26, 1874, when he found at 270° several eruptive jets, above which floated a brilliant prominence, with an apparent height of 3′ 37″. Observed with the slit opened sufficiently wide to admit the entire prominence between its jaws, the prominence resembled an immense fiery comma. But with a

* *Phil. Trans.* 1864, plate xi.
† Dunér, *Les Etoiles à Spectres de la Troisième Classe.*